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THE EPILEPTIC INTERVAL—ITS PHENOMENA AND THEIR IMPORTANCE AS A GUIDE TO TREATMENT.[1]

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A RESTATEMENT and amplification of the known interparoxysmal manifestations of the epileptic may in two ways aid us to a rational treatment:

1. To a certain extent by furnishing positive indications for the transient or constant use of various remedies, especially with a view to the more exact application of those recognized as possessing some value.

This is simply in line with present demands, as various writers (Seguin, J. Stewart, Diller), have called attention to the diverse nature of the cases classed under this head, the necessity for individualization, and the importance of training the nervous centres, and of "general measures conducing to the proper performance of function in every organ and tissue of the body."

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[1] Read in part before the Brooklyn Society for Neurology, Feb. 11, 1891, and in abstract at the meeting of the Medical Society of the State of N. Y., Feb. 7, 1893.

2. Principally by supplying an index to the progress of the disease, independent of the seizures, and hence a guide to the regulation respecting abatement of treatment where progressive improvement results.

General descriptions of epilepsy, and statistical works bearing thereon, are numerous, and in their way fairly satisfactory. But the symptoms of the seizure, the general type of the accession, pre- and post-spasmodic phenomena, and pathological findings have absorbed the attention of observers and a large space in all descriptions. These are largely intermittent, often not observable by the physician, and withal of little importance to us except diagnostically. Commonly there are some phenomena immediately preceeding or following the convulsions, that are attendant rather than interparoxysmal. Where the attacks are very frequent these quasi-spasmodic manifestations may, of course, be present during the whole interval. These need only be mentioned here when closely allied to the phenomena to be described,—though it is not always clear how far the latter are but residual effects of the convulsions, and how far independent symptoms.

Then there are various continuous conditions occurring in or affecting these patients, and that go to complete any full description of epilepsy, but that must here for the most part be ignored.

But there is a mass of other phenomena, fairly continuous or frequently recurring in the interim of attacks, not characteristic, and hence diagnostically of only relative value, yet of the greatest importance in guiding treatment. As confirmative evidence of the existence of epilepsy, however, their value is greatly enhanced by the fact that most of these aberrations are *objective*. Some may choose to class them as neurasthenic symptoms; but if so, they are those of epilepsy and none the less valuable. These matters are usually passed as insignificant or too uncertain to be further considered. Little, if any, notice is taken of them in the recent works on this subject; though more in a few special articles. The best consideration of them, so far as it goes, is in an old but most admirable paper by J. R. Reynolds. ("Some Phenomena of the Inter-paroxysmal Condition of Epileptics, and their Relation to Treatment." (*London Lancet*, 1855, ii, 100; 120).

Hence we may clinically distinguish paroxysmal, pre- and post-spasmodic, interval, and continuous conditions in epileptics,—these, of course, to some extent, overlapping and passing into each other. This brief recapitulation and classification of clinical features shows more definitely the limitations of the field included in this paper. It was my original purpose to present only personal observations, but some reference to the work of others will help to make this outline more interesting and systematic. As a basis are taken the notes made in 150 consecutive cases of epilepsy seen in dispensary practice, in years 1884 to 1891 inclusive. Of course, such data are in many cases very incomplete. In estimating the frequency of single symptoms, only a portion of this number can consequently be utilized according as each symptom or its importance was recognized. As regards many of these, some inconstancy of occurrence even in the same person was common. The patients have been, for the most part, of fair mental ability, thus contrasting with the more degenerate and advanced institution inmates on which many of the large records have been based. From the nature of observations made under such conditions, the proportion of anomalies found will err, if either way, in being too small. For convenience these will be considered under the various organs or functions as headings.

(1).—THE PUPIL.

A. Inequality in size. This matter has already been treated (JOURNAL NERVOUS AND MENTAL DISEASE, Jan., 1892.)

B. Oscillation of the Pupil (Hippus pupillæ).

This proves to be one of the most constant interparoxysmal manifestations in epileptics. Excluding the insane, it is with few exceptions to be found in all cases when carefully sought, though, of course, varying greatly in degree. Some note regarding this was made in 41 cases. These were not all consecutive, as some were too restless for a satisfactory examination of this point, and others were referred or briefly seen once and then lost sight of. But the proportion of positive and negative results must be fairly correct [2] for this class of patients.

In two of these cases, both girls, no definite oscillation was detected (but two absolute negatives in forty-one cases). In five others it was absent or doubtful at some time, but reappeared; resp. was first detected at a subsequent examination. In perhaps eleven others (9 m., 2 f.) it was usually slight in extent though unquestionably present. Of the thirty-nine positive cases twenty-three were males and sixteen females. This corresponds to the proportion of males and females in the whole series, and certainly shows that it is not a special result of feminine characteristics (oversensitiveness, hysteria), though possibly more marked in that sex.

It should be remembered that normally, on reducing illumination, the pupils dilate evenly and steadily, and on arriving at the proper maximum width simply rest there. This does not exclude a decreasing rapidity as they approach the resting point; nor a considerable variation as to the promptness with which they respond, the speed with which the response ensues when once begun, nor the extent of their response.

But in the cases here referred to, there are excesses and irregularities of pupillary movement not to be explained by any of these normal variations.[3] Several distinct but frequently co-existing types of this anomaly can be distinguished.

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[2] In private practice, perhaps owing to the quieter circumstances under which the patients are seen, the proportion of positive cases has seemed to be less, though not radically so.

[3] In the every-day use of the ophthalmoscope, as my friend Dr. Alleman informs me, it is not uncommon to observe a slight fluctuation in the pupil on first throwing the light into the eye. Whether this be due to involuntary changes in accommodation or to other influences is not clear.

1. In this form the act of dilating only is peculiar. This takes place in a series of jerks; a very slight contraction often, but not always, occurring at the pauses. As a result, the whole period to the maximum dilation is considerably prolonged. When present, this peculiarity is usually bilateral; *i.e.*, it may then be observed in either eye on covering the other. However, it may not be equally marked in the two eyes. It is occasionally observable in older children, in adults and in those suffering from other troubles, or, at least, not known to be epileptic. This form was noted in eight cases, although the minor distinctions were not always recorded. Even more minute descriptions might be given, as *e. g.*, a slow wavering dilatation that ends with a big jump.

Charpentier has called attention ("Behavior of the Pupils in Epileptics," quoted in *Therapeutic Gazette*, May, 1890,) to a condition that he describes as "a rapid, transient, and variable difference in the size of the two pupils, somewhat resembling the temporary inequality produced by closing one eye for a short time and then suddenly opening it. The phenomenon is produced sometimes at very short intervals in the same subject; it is unconnected with any fit or vertigo, or other symptom of epilepsy, and it has no prodromal significance; but it would appear to be liable to be evoked in any epileptic when he is under the influence of emotion, especially if he has difficulty in expressing himself." C. has not seen it occur apart from emotional disturbance and effort, and so far has only noticed it to be a dilation of the pupil, progressively increasing or alternately dilating and contracting. He thinks that if these observations are confirmed by others, the sign may be of value as revealing the existence of the epileptic neurosis. From his erroneous view that the pupils become unequal on covering one eye for a time, it is probable that what C. really observed was hippus of the type just described.

2. The reverse of this—*i.e.*, a serrated contraction—has not been observed with certainty in any of these cases,

and is withal of rare occurrence. Recently H. C. Wood (*Univ. Med. Magaz.*, April, 1889, p. 385,) published such an observation in a non-epileptic case, but where there was lateral homonymous hemianopsia from a tumor in one temporal lobe, with softening, etc.

A simulation of this reversed serration may occasionally be noticed in epileptics, viz.: when the reflex-contraction is limited (*e. g.* in very poor illumination) and immediately passes into that form of tremor soon to be described (*v. infra*, form 4).

3. This form is also a part of the dilating act. It seems to be intermediary between the first and fourth forms, although less frequent than either. Here the primary dilation occurs smoothly, but instead of stopping at the right point it goes too far. Then it contracts back also too far. This leads to a short period of diminishing contractions and dilations until the pupil settles down steadily at the proper width. The first dilation usually achieves the greatest maximum, each succeeding one being less.

4. This form, although classed under hippus, might be distingushed as tremor pupillæ. Here the oscillatory movement of the pupil does not occur as an apparent feature of the reflex act, but is more or less continuous. If pronounced, it can be observed when both eyes are exposed (illuminated). It is the most common form (34 times). The extent of this spontaneous motion is very variable, and in the two eyes not always equal, *i. e.*, on covering one eye the tremor of the opposite pupil is greater than is observed on reversing the procedure. But in many cases its average is fairly constant for considerable periods—weeks and even months—though the seizures be fully controlled.

The motion may be called rhythmic, though it does not seem to follow any sequence, a slight movement being followed by a larger or an equal one, or conversely, without any apparent rule or equal interval of rest.

Evidently, a variety of this is where, on exposing one pupil, a steady, even slow, dilation occurs and seems to stop quietly at its maximum; on continuing the observation for some seconds, however, a variable, slow, but often increasing oscillation, becomes apparent.

In examining for these pupillary movements, there are certain necessary or favoring conditions:

(*a*) Vision should be directed to a distant object, *i. e.*, convergence, and accommodation excluded and the irides correspondingly relaxed—an attitude of staring. With many patients this is easily accomplished; but there are numerous epileptics at least, including older and willing patients, who seem quite unable to keep their gaze steadily fixed.

(*b*) The phenomenon is decidedly more pronounced on exposing only the observed eye, the other being covered. Frequently it can only be detected in this manner, and in all cases the type can thus be more satisfactorially studied.

(*c*) The oscillation is greater in poor than in strong light. Consequently a dull day, twilight, or some distance from the window or source of light is most favorable. In total darkness these movements might be still greater, but, for purposes of observation, some illumination is imperative. Of course, whatever be the illumination, it should not vary during any single observation.

(*d*) Mental or psychic stimulation has been found to greatly increase the extent of the oscillations. Some have attributed similar mobility wholly to mental effects.

(*e*) Before excluding every form of hippus the observation should be continued for a full minute or two, should be made on each eye singly, and should even be repeated after a week's interval.

On the contrary, very dark eyes, browns and blacks, render such observations far more difficult, and as they require better illumination, a negative result is more probable.

Some few previous observers have remarked the occurrence of hippus in epileptics. Charpentier has been already mentioned.

Schmeichler (*Wiener Med. Wochenschr.*, 1885, No. 41) says that he has seen what he terms "spontaneous pupillary movements," "besides in healthy, generally sensitive individuals, mostly in females, the number of which is not great; in drinkers,[4] *e. g.* directly after an attack of delirium tremens, and in epileptics on the slightest psychical stimulation." In one of S's cases (suspected epilepsy in a soldier) it served to warrant the diagnosis until more certain proof was obtained. He adds, that so far as he knows the only previous observer of anything of the kind was Schadow, "who says he had seen variations in the size of the pupil during continuous equal illumination: these he referred to the influence of psychic and sensory stimuli."

Schmeichler concluded that these pupillary movements were synchronous with the respiratory as observed on the cerebral vessels. My various attempts at confirming this explanation, so far as it applies to epileptics, has been but partially successful. In a majority of such patients—S's explanatory observations were made on other cases—there is no visible connection between the respiration and these movements. In a few, however, some relation between the two can be made out, although even then the dependence is but partial, the respiration merely affecting or increasing the hippus without entirely controlling it. Occasionally the winking act also affects it either as a coördinate action, or more probably through a quickly responding light-reflex. The interesting observations of Dr. C. A. Oliver in a case of migraine are also against the theory of a respiratory cause, (noted in Sinkler's article, *Med. News*, July 19, 1890, Repr.): "Spasmodic action of the right iris, causing the pupil to dilate and contract irregularly; this spasmodic action being felt by the patient as a twitching or a series of movements." A couple of years later, at an attack, the following was noted: "The right-sided hippus was again complained of, and upon careful study was found just as pronounced as at the previous examination. The iris excursions, which were quite extensive, were found to be fifteen times in each half minute upon monocular exposure, and but six times in the same length of time upon binocular exposure."

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[4] This cause is noticeable since alcohol, in the case of some individuals, suffices to bring on convulsions.

Damsch has observed "hippus,[5] aside from affections of the eye itself, in changes in the chiasm with subsequent hemianopsia, in paralysis of the oculomotor nerve, in nystagmus, in epilepsy, in the early stage of acute meningetis, but relatively, most frequently in multiple sclerosis. * * In chorea there was no hippus. Neurasthenic patients showed it occasionally."

It is true that hippus is very common in disseminated sclerosis; in fact sclerosis, chronic alcoholism, and epilepsy are its main causes.

Are these pupillary movements simply the result of the convulsions, or are they coördinate phenomena, indicative perhaps of an unstable condition of the sympathetic? The latter view is undoubtedly the correct one in the main. For, in several cases, it has been possible to follow them months after the cessation or subjection of all paroxysmal manifestations. In such instances the hippus may continue for a long time unchanged, eventually to subside by degrees if a real cure is achieved. This is further indicated by the fact that, in the first form, the oscillations occur only during passive dilation, and in the fourth are stronger, the more the influence of the oculomotor is excluded (*v.* also Damsch's observation, above cited, of hippus in oculomotor paralysis), *i. e.* they occur in either form so soon as the dominating influence over the pupil is left to the sympathetic. This view must be correct unless we assume that the oculomotor innervation becomes rythmic when weakened.

This might suggest the old theory that the convulsive disorder rests on vasomotor spasm, or, better, that in epilepsy the sympathetic control is unstable, weakened or wavering. And C. A. Vanderbeck (*Phila. Med. and Surg. Reptr.*, 1877, i., p. 411) mentions oscillatory movements of the iris as a premonition of an epileptic attack, whilst other observers have noticed rapid pupillary changes as occurring in the post-paroxysmal stage (exhaustion or reaction).

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[5] "On Pupillary Unrest (Hippus) in Diseases of the Nervous System." *Neurolg. Centbl.*, 1890, (*v. Knapp's Arch.*, April, 1891).

The ages of the epileptics showing hippus have ranged from 6¼ to 51 years. There were six observed therefore, over twenty-one years of age, and of these six but one failed to show some hippus. The oldest was a man of fifty-one years (attacks for four years but only every few weeks; a moderate drinker). The number of these older patients showing hippus is too limited to warrant such positive conclusions as to its frequency in them as do the younger cases.

In fifty-six epileptic insane (15 f., 41 m.) whom I was enabled to observe at St. Johnland last summer through the courtesy of Dr. H. J. Knapp, then of the Asylum staff, this phenomenon was not marked in any case and was absent in a majority:—negative, or so slight as to be doubtful, 33; slight, but distinctly obtainable, 17, including five in which it was unilateral; too restless for observation, 6. This small proportion was not due to age, as of the ten minors included only two were positive. The trouble in controlling, accommodation, etc., in such patients render their statistics on this point of less value except as showing the general fact that the epileptic insane exhibit this manifestation to but a slight extent. Hence, as its degree or occurrence in them also bore no relation to the frequency of their attacks, it is evident that the hippus is not an effect resulting from the seizures but is a separate or coördinate matter.

It is of course necessary, in order to correctly estimate the value of this symptom, that we should know the frequency with which it occurs in non-epileptics of like age.

Schmeichler (*l. c.*, No. 41, 1248) says: "These spontaneous pupillary movements—so far as they occur in normal individuals—are less often observable in males than in females; the puberty-years present the largest contingent; in old people I have never seen them." However, in fact they do occur in morbid conditions now and then in persons up to middle life and thereafter.

As to their frequency in non-epileptic children, the large number of choreics under observation at the same time as the epileptics furnish a good criterion, inasmuch as they are also suffering from a nervous affection. Occasionally a choreic child also exhibits this hippus, despite the statement of Damsch, but the proportion is small. In fully healthy children I have never discovered any indication of it.

As to the differential diagnostic value of this sign, it follows from what has been said, that it can only be relative like most other symptoms. But as it is objective, it may at times prove very valuable. A better knowledge of its frequency in other troubles will here prove useful.

Before closing with the pupil, it might be specified that these phenomena of themselves do not call directly for any treatment. Possibly they may suggest the propriety of remedies specially acting on the sympathetic system.

NOTE.—It was claimed by L. C. Gray (*Am. Jrnl. Med. Sc.*, Oct., 1880, also *Am. Jrnl. Neurlg. and Psychiatry*, vol. i., 1882), that a dilated and mobile pupil was diagnostically significant of epilepsy. He says: "By a dilated and mobile pupil, I mean one that is always more or less dilated, even in bright light, and which undergoes the changes from contraction to dilation; and conversely, in response to light or accommodative movements, much more quickly than does a normal pupil."

This was quickly combatted by P. Maric (*l. c.*) from Charcot's clinic. Musso (*v.* Hare) made similar tests on seventy epileptics and ten healthy persons, with conclusions, as regards Gray's statements, corresponding to those of Maric.

There is, however, a probable element of truth in Gray's claim to an unusual proportion of wide pupils amongst epileptics as he observed them, his critics examining a different class of patients and under other circumstances. The assumed over-mobility of pupil described by the above quotation would, however, be something quite different from hippus, and is only mentioned here to avoid possible confusion.

As to the condition of the pupil in the attacks, Seguin (*Bost. Med. and Surg. Jrnl.*, 1891, i.) gives dilation and immobility as constant in *grand mal*, frequent in *petit mal*, and uncommon in psychic epilepsy.

ZONULAR THICKENING AND PIGMENTARY CHANGE OF IRIDES.

There is another peculiarity, of the iris rather than the pupil however, that is frequently noticeable in epileptics. It is also common in a variety of other subjects, as old drinkers, one case of slight rheumatic neuritis, persons giving evidence of premature senility—in a word, the physically degenerate. Perhaps it is on a par with the well-known *arcus senile*, though coexistence of the two was noted in only one case.

The peculiarity *in appearance* consists of a thickening of the iris, progressively increasing on its exposed surface from its periphery to the outer border of the narrow circularly contracting inner ring (*i. e.*, to the zone of the constrictor pupillæ), which latter preserves fairly its natural thin appearance. During the contraction and dilatation of the iris this outer band is seen to remain immobile like a shoulder-ring, inside and perhaps beneath which the active part plays. At the same time this major part of the iris in seen to have lost its bright "finished" and mottled surface, and to be of a dull, sodden, even color. This condition has alway been bilateral—apparently equal on the two sides. In younger epileptics there is often an iridial condition present that may represent an early stage of this peculiarity. The outer surface then has a hazy indistinctness almost impossible for the observer satisfactorily to focus, without, however, having, to any great extent, lost the general tint of its original color, nor as yet developed a marked shoulder. Irregularity and variety of pigmentation in the same iris is then not rare.

My records do not warrant any exact statement as to the frequency of these conditions in epileptics, except that they are common (especially noted in ten cases, the youngest 13 years of age).

As to any tendency to a narrowing of the pupil or slighter reaction to mydriatics—both of which might be suspected if there is an analogy with senile conditions—I have no observations to communicate. And the same holds as to whether the condition, even in its partial form, is recoverable. My ophthalmological friends have not been able to offer any information with regard to the matter, unless the suggestion of an œdema-like infiltration of the relatively inactive portion of the iris. Possibly in the epileptic cases the continuous pupillary oscillations above described are a factor in its causation.

(2).—OTHER OCULAR PECULIARITIES.

A. OF THE MOTOR APPARATUS.

1. The various anomalies in refraction and the relative muscular insufficiencies are matters that have been so recently discussed that they may be quickly dismissed. Briefly, the theory seems to be that the effort required to overcome temporarily these impediments to perfect vision tires the nerve-apparatus and so excites or frees the convulsive centres. However, in many cases, these ocular weaknesses or defects may more justly be regarded as results, or as interphenomena of the epilepsy and of the attending weakness of the nervous system than as its source. Ocular errors in epileptics certainly should be corrected as carefully as possible, just as all other aberrations from the normal.

2. Distinct paresis paralysis or contracture of external eye-muscles is much more frequent in epileptics than in average persons. This may develop suddenly at some convulsion. Mauthner has suggested that such an occurrence often depends on the development or existence of a tubercle (somewhere in the central path), and this probability may be worth remembering in the treatment. Where the epilepsy proves amenable this condition may improve and even disappear.

Altogether, there has been such easily recognizable weakness of one or more external eye-muscles in ten of the last sixty-seven cases. Of these ten, there were six with distinct paresis or strabismus, and four of latent diplopia; of these four, however, one showed unilateral ptosis, another slight latent anisocoria, and a third slight (paretic) nystagmus on extreme conjugation as also relative weakness of one abducens. By deducting from the sixty-seven the twenty-four who were over 21, we find that all the ten cases were in the forty-three consecutive patients under age—certainly a surprising proportion and perhaps too large for general application.

Schleick (*l. c.*) notes the frequent occurrence of squint in the absence of any motor paralysis of the eye. Hare (p. 22) mentions diplopia or hemiopia as sometimes existing for twenty-four to forty-eight hours before an attack.

The fact that in one patient strabotomy had been performed before onset of the epilepsy, that one patient has a healthy boy with congenital unilateral ptosis, and another, a sister, with a turning-in of one eye from fright, suggests that we should be guarded in attributing grosser disturbances in the eye-muscles to the effect of the seizures.

3. Various epileptic patients have shown a peculiar restlessness of the eyes, an inability to steadily concentrate or long continue visual attention, whether for far or near objects. This is quite different from nystagmus which, aside from paretic eye-muscles, does not seem to be common.

B. OF THE RETINA.

1. Ophthalmoscopic changes.

The condition of the retinal circulation in epileptics has been the subject of much observation and mild contention. Vance (*N. Y. Med. Jrnl.*, 1871, i., 144,) endeavored to obtain a therapeutic indication from the state of the retinal vessels. In anæmic conditions he used strychnine, alternating this with bromides when any hyperæmia was noticed. Clifford, Albutt, Cross, and others, have noted changes believed to be more or less characteristic. But Gowers, and many expert ophthalmologists have since thrown discredit on the availability of such observations. Knies' investigations (1888) had reference only to the period of attack. Oliver (*l. c.*) has, however, since reached the following positive conclusions: "(10) Optic disk superficially over-capillary, with a decided grayness in its deeper layers, showing a low grade of incipient optic-nerve degeneration. (12) Fibre-layer of retina increased in thickness, as evidenced by dense and course massings of striation extending in all directions from the disk, these being more particularly marked in the superior and inferior portions of the eye-ground, even hiding the edges of the disk itself in many instances. (14) The retinal veins exceedingly tortuous, and in a few instances pulsating. (15) Retinal arteries frequently wavy and sometimes tortuous, especially the temporal and macular twigs. (16) Retinal lymph-channels visible in the majority of cases, particularly seen along the larger vascular distributions and at the vessel-entrance as glistening and yellowish opacities."

Schleick found no gross ophthalmoscopic retinal changes, although in 52 of his 127 cases (41%) slight deviation from the normal.

Gottardi (*v.* Journal Nervous and Mental Disease, Oct., 1881, p. 843): "Permanent alterations of the fundus of the eye are most frequent in cases presenting a symmetry of the face and skull, already recognized by Voisin, Müller, Dumas, and Hasse. During the attack, and better still, after the attack, temporary alterations occur in the vascularization of the fundus of the eye, or, isolatedly, of the central vessels of the retina. These alterations are, however, of no value as a means of diagnosis in cases of simulated epilepsy, as they occur under the influences of other causes."

It is scarcely necessary to quote further on this point. Until the ophthalmologists can offer more definitely accepted positive results, we are warranted in ignoring the retinal appearances so far as the epilepsy is concerned.

2. Limitations of Visual Perception (field, color, etc.).

C. A. Oliver found (in Asylum cases, however,) the visual fields for form and color reduced from $\frac{1}{3}$ to $\frac{1}{20}$ of normal areas, the diminution being regular without indentations or scotoma, and the color-perception being subnormal to a slight degree.

This hamonizes with the investigations of Wilbrand, Ottolenghi, Thomsen, and in part, Lombroso, who found even concentric contraction of the visual field with sometimes a diminution of visual activity, such changes, however, being largely due to the paroxysms.

(3).—THE HEART AND ITS ACTION.

Though numerous recorded cases have shown that abnormal cardiac manifestations occur in epileptics, often with irregular action of the vasomotors, the matter does not appear to have received its share of attention. The subject is here followed out almost exclusively on the pulse, or by auscultation. With a little experience and care everything of importance can thus be detected, and this with greater certainty and satisfaction than by any of the common sphygmographs. Tracings in several cases, made with a Dudgeon instrument, showed graphically such variations as could be most readily followed in that manner. But equally important matters can not easily be thus recorded.

It soon transpires that a sound and normally acting heart is the exception rather than the rule in epileptics. Of the following deviations therefrom—these are simply such divisions as I have found clinically convenient—more than one is often observable in the same patient, and some individual variation from time to time is not uncommon.

Rarely there is organic disease of the heart, in the shape of valvular defects, dilatation, hypertrophy, fatty degeneration, etc. Far more frequently functional disturbance is all that can be made out. From the nature of dispensary work it has not been possible to examine many by percussion, and the few so examined failed to show much of interest.

No mention of the pulse or heart is made in thirty-six cases. Some of these did in fact also present cardiac symptoms but that failed to get recorded. This impairs the exactness of the statistics, though not their general bearing. In sixteen of the remaining 114 cases it is specially stated that nothing abnormal or worth mentioning was found. As nine of the sixteen were seen but once, it is possible that they were not studied with the requisite thoroughness. There were, however, definitely negative results sufficient to show that, so far as the methods of examination practiced could determine, there is a certain proportion of cases—not over one-third at the most—that fail to show any cardio-vascular symptoms. It is on the other ninety-eight cases that the following positive observations were made, these representing per contra at least two-thirds of the whole series.

The so-called epilepsia vasomotoria is a special form of attack, and therefore is here excluded.

A. VALVULAR LESIONS.[1]

Rarely these are factors in causing epileptic seizures, though, even when present, their significance has been questioned. Whether or no such a lesion is ever produced by the paroxysms, certainly when once started it may thus be increased in degree. The fact that it is often the mitral does not help much in deciding.

There were four of these cases (in the 150) besides four others in which the sounds were blurred or obscure. Although many cases were not auscultated, still this was done in all presenting suggestive symptoms, and it is believed that few, if any, marked cases of this kind were overlooked. The four positives all showed mitral murmurs (regurgitant). Two were in females (aged 7 and 50 yrs.), and two were in males (aged 48 and 63 yrs.).

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[1] These, with the furred tongue, the adenoplasias, etc., described below, of course really fall under the head of continuous conditions mentioned in the introduction.

Hence this condition is evidently more common in adult than in young epileptics. In at least two of the three adults, the seizures developed each time on signs of the heart failing, but were quite banished as soon and so long as the heart worked well. In such cases there can be little question of the etiological relation of the cardiac injury. Here the seizures have some of the elements of a syncope, but their suddenness, an occasional biting of the tongue, and some convulsive movements attest their kinship to epilepsy. Doubtless, the weakening effect on the circulation is the factor for evil. In one case, as the heart-trouble became less and less compensated, the seizure diminished to forms of *petit mal*, though recurring much more frequently.

The literature on this point is considerable, as a few references will show.

Flint once described ("Diseases of the Heart and Epilepsy," *Am. Med. Ti.*, Jan. 12 and 19, 1861) the case of a man of thirty-two, in whom epilepsy was believed to have developed after damage to one or more valves, although considered merely a coincidence. The Index Catalogue mentions an early case of Horn—"Merkwürdiger Fall einer Epilepsie von einer organischen Krankheit des Herzens entstanden," *Arch. für med. Erfahr.*, 1808. J. W. Martin has published such a case ("Epileptic Seizures; Presystolic Mitral and Systolic Aortic Murmurs; Anæmia; Health Improved Under Treatment." *Med. Press and Circ.*, 1875, i., 383).

In four of the five cases given by Hollis ("Epilepsy with Cardiac Complications," *Practitioner*, 1879) there were signs of valvular trouble and cardiac enlargement. Lemoine (*Rev. de Medc.*, 1887, quoted by Hare) reports "five cases of cardiac epilepsy, in which valvular disease of the heart existed, and where great amelioration of the symptoms or recovery occurred upon the use, either singly or together, of such cardiac stimulants as digitalis and caffeine."

Valvular murmurs were made out by Dr. Knapp in eleven of the fifty-six insane. These were all aortic but two, and none were very marked—representing presumably slight and purely secondary changes.

CARDIAC EPILEPSY.

Evidently some confusion exists in the use of this term. Various writers have endeavored to distinguish a so-called *cardiac* epilepsy due to organic (valvular) disease of the organ. This form is sufficiently illustrated by the cases just cited, except that any disabling organic affection of the heart may doubtless be as deleterious as exclusively valvular affections. As to the real existence of this form and as to its importance there can be no question. The confusion has arisen from the designation chosen therefor; since, under a like title, an altogether different form—and one not further belonging here—has been described and seems to be more often intended (Stokes, "The Partial Epilepsy of Trousseau"—more strictly a local epilepsy like the various tics; the "Cardiac Epilepsy and Essential Tachycardia of Talamon," 1891; "Paroxysmal Essential Cardio-motor Nerve-storm" of H.C.Wood, 1891).

B. RAPID PULSE—TACHYCARDIA.

The paroxysmal form of this just referred to, is, of course, not here intended. But otherwise, this is very common. It was noted in fifty-three of the cases, besides a dozen or more others in which it was but slightly, or at times increased in speed. By this is meant a pulse that is commonly or continuously fast, and not merely so from some passing cause. In children, especially, allowance must be made, not only for the normally increased rate, but also for excitement from the examination, though this latter disappears on gaining the little patient's confidence.

Hence, we may conclude that an overrapid pulse is more or less constantly present in from one-third to one-half of all cases of epilepsy.

As to what should be termed a fast pulse when the person is sitting quietly, it is here assumed as eighty or over for adults and ninety or over for (older) children. Twice (in children) it has run as high as 120, while 116, 108, 104, 100 are fairly common. After making the above allowance of ten more beats for children, there does not seem to be any special influence attributable to age or sex, although some to the frequency of seizures.

This symptom can usually be controlled by digitalis. But it requires a very careful adjustment of the dose, as an over-effect is but too readily produced, or a fast but regular pulse gives place to an intermittent or irregular one. It seems impossible in some cases to get the desired even regulating effect of the drug. The more the rapidity is due to local conditions of the heart, the better the effect of digitalis; the more it is due to central and nervous conditions, the less amenable does it seem to this drug (as to influence of enlarged lymph-glands, *vide infra* sub 9). The average in forty-one male epileptic insane, as determined for me by Dr. Knapp, was $91\frac{1}{2}$, and for fifteen female $92\frac{1}{4}$.

THE PULSE-RATE AT DIFFERENT AGES.

As a standard for estimating aberrations in speed, the results recently worked out by Langlois (*vide Bost. Med. and Surg. Jour.*, 1891, II., p. 68) for the normal pulse may serve: "Between the ages of fourteen and forty-five the normal rate is very nearly 70 beats per minute. Below the age of fourteen the normal rate may be found by the formula $P = 140 - .5A$, the pulse-rate being represented by P and the age by A. After the age of forty-five it is found by the formula $P = \frac{1}{2}(95 + A)$."

However, in applying any such standard to ambulatory patients some little margin should be allowed before classing a speed as either abnormally fast or slow.

C. WEAK HEART.

A small or weak pulse was noted in twenty-nine cases (11 m., 18 f.) exclusive of the few showing valvular troubles. To a large extent these were the same cases as those with a rapid pulse (eighteen of the twenty-nine cases), though the reverse is not as striking.

Of course this is largely a matter of judgment, and can only be estimated after duly considering the patient's age, sex, physique and activity. The fact that an over-proportion were females suggests that due allowance may not have been made for sex.

Again, often there is so much variation after either short or long intervals as to exclude the case from this category.

In twenty-four of the fifty-six insane, a weak heart was specially noted by Dr. Knapp—and this does not include those with valvular lesions.

D. SLOW PULSE—BRADYCARDIA.

An abnormally slow pulse, 48 to 60 beats per minute, was noted in only six cases—the youngest aged sixteen, the others over thirty. Though the pulse-rate in none of these was below 40, it is now recognized that bradycardia, even in the latter restricted sense, is occasionally an epileptic accompaniment. The more pronounced of these cases, as also the more typical of those quoted below, were all in males.

Recent investigations show further that it may be difficult to distinguish between slow and certain forms of intermittent pulse (*v. infra.*). Many of the cases are reported by English writers, usually under the qualifying designation of Epileptiform.

F. St. George Mivart (*Lancet*, Jan. 3, 1885) describes this in a man of sixty-one years—P. 20 sitting, 24 standing.

A. F. Gibbings (*ibid*, No. 7) reports a case in a man of sixty years, with a previous intermittent pulse of about 60, but which on the development of epilepsy dropped to 12 and then until death continued at from 24 to 30 beats.

Drummond (*Brit. Med. Assoc.*, reported in *N. Y. Med. Recd.*, 1890, ii. 333) tells of a man with a pulse of 13, increasing to 36 and 40 during an attack of influenza, and then falling to 5, 10 or 15 per minute before the advent of the epilepsy.

Corkey and Hubberty have also (*Brit. Med. Jrnl.*, May 10, 1890) contributed a case in a man of sixty, whose pulse ranged from 11 to 76. The convulsions occurred during the intermissions of the beat. Autopsy showed mitral incompetency.

In Sigg's case (given by Seguin in Sajous' Annual, 1889) the pulse-rate finally sank until it was only "24 to 21 per minute, with intervals at times of from 5 to 15 seconds. In many of the attacks the pulse was only 9 per minute, with indistinct tremulous heart-sounds and a faint systolic murmur."

These cases are somewhat different from those of the present series. The slow pulse seems in part to have been a paroxysmal occurrence; again some more or less marked organic change in the heart was evident. No particular significance seems as yet to have been attached to this symptom, except that when very pronounced it favors the advent of the seizures. Dehio (1892) has found that atropine relieves bradycardia when due to nervous and not intra-cardiac troubles.

E. IRREGULAR HEART—ARYTHMIA, INTERMITTENT PULSE.

Under this head are often included the three types next following, but in practice it is nearly always possible to distinguish them.

In arythmia, as here intended, there are more or less sudden breaks or changes in speed. The jump may be either slight or great, and either to faster or slower rate. Commonly these sudden alterations show no definite regularity in their recurrence or extent. In the closely allied Intermittent Pulse the beats may be dropped, only now and then, in some of which cases it is accordingly necessary to observe a long series of beats and even on different days before it is detected. In other cases there are sudden pauses and complete breaks in the pulsation.

Naturally the first form of this shades off at times to the next type—that of Variable Rhythm. Exclusive of the valvular cases an Irregular Heart was distinctly observed in only ten (6 m., 4 f.). In at least some of these it had no direct dependence on the convulsions. Distinct irregularity or variability was noted in ten of the fifty-six insane epileptics.

Hollis (*l. c.*) says: "In the majority of these cases this [cardiac] derangement showed itself in that rapid and irregular pulse which has been * * * * * described as diagnostic of muscular feebleness of the cardiac organ." The following from a German review of Bard's article (*Gaz. hebd.*, 1890, No. 18) is especially relevant to this form: "Permanent rhythm couplè, of which the so-called pulsus bigeminus is the lightest form, occurs in severe affections of the nervous system. In these are found the highest degrees of the arythmia in question, and which can very easily be mistaken for an abnormally slow pulse. According to Tripier this form of pulse is found particularly in epileptic affections, especially in larvated forms of the same."

F. VARIABLE SPEED OR RHYTHM.

This is very frequent. It was noted in forty-five of the one hundred and fifty cases (27 m., 18 f. or as 3 : 2). As forty-one of these were in the last one hundred cases it may be concluded that like the rapid pulse this is present in over one-third of all cases. However, tachycardia and variable rhythm were both observed in the same patient only 21 times, showing that there is only a limited interdependence between the two.

The change in rapidity of beat may take place almost suddenly and then, though slight, be very noticeable—approaching definite arythmia. Or the variations may be quite gradual, *i. e.*, the change may be of either quick or slow completion. Again, the variation in speed may follow a regular sequence, or be entirely irregular in its occurrence. In still other cases it is only noticeable on comparing different days, one day regular at say 84, the next time 108, then 90, etc.

To examine for this point fairly, all influences that ordinarily suffice to affect the rhythm should be excluded; the patient must first have settled into as quiet a condition as possible, both physically and mentally.

G. VARIABLE FORCE.

This is closely allied to the previous form, yet the two are far from parallel. The rhythm may continue perfectly uniform and yet the force vary (two cases).

This also may occur slowly, like a long wave, up and down, or it may intersperse level intervals, or again be characterized by some suddenness without becoming disstinctly irregular. Like the Weak Pulse, its estimation is largely a matter of judgment.

This pecularity was noticed in ten cases (6 m., 4 f.), but this limited number probably includes only those in which it was prominently marked in comparison with the previous forms.

H. IRRITABLE, SUSCEPTIBLE, OR CHILDISH HEART.

This is where its action is too much or over-easily affected, as by mental effort or rising and sitting. It is closely allied to Variable Rhythm, and in several cases (8) both were present. This peculiarity is rather common, both with and without other definable aberration in the heart's action. Still it was specially noted in only twelve cases (7 m., 5 f.). One of these patients was but eight years old, the others all over fourteen.

Though Irritable Heart has been recognized since the time of Graves, it is not often mentioned and has perhaps no mathematically exact significance. As an example, if on directing a youth's attention to some unexciting matter or on simply engaging him in conversation, his pulse-rate suddenly increases 20 beats, he has been credited with an Irritable Heart.

I. SENSATIONS (PALPITATION, PAIN, ETC.) IN THE HEART REGION.

Such subjective phenomena throw little light on the primary condition; nor is it always possible to say with certainty what is the real seat. An aura from this part is not rare, and in some other cases the sensations are associated with the attack. Otherwise, palpitation is most frequent in adult females (16 cases in all; 6 m., 10 f.) and is withal more common than all other sensations together. In two of these (1 m., 1 f.) it was, however, only associated with the attacks, 1 (m.) only suffered at night, and 1 other (m.) had a mitral lesion. Of these sixteen, there were thirteen over twenty-one years of age, indicating that it is principally an adult symptom.

There was also eleven cases (7 m., 4 f.) that complained of unpleasant feelings in this region. Direct complaint of pain is now and then heard (in one case associated with dyspnœa, in one in the mornings, in another from walking), though it is more often a "lump" in the cardiac region, "in the left side," in the region of the stomach, etc.—perhaps gastralgic.

It is principally in angina pectoris that there is any understanding of the relation of local sensations to the cardiac condition. However, Nothnagel has recently described the frequent painful sensations—anginal and continuous, also cutaneous hyperalgesia of precordial region—in valvular affections especially aortic. He adds that quite analogous painful sensations occur in affections of the myocardium without valve-trouble (myocarditis, fatty heart, hypertrophy, both idiopathic and especially from arterio-sclerosis). Chew (1892) divides cardiac pain into three forms—true angina, pain from Bright's disease, pain from dilatation of heart.

Fear and timidity as a characteristic is so common to children that little account can be made of it. That its physical basis is so often associated with cardiac irritability or undefined sensations from the cardiac region, and that fright and sorrow are among the recognized causes of epilepsy, are the reason for mentioning it here.

REMARKS ON THE CARDIO-VASCULAR SYMPTOMS.

Observations of some length and at different times are requisite before all these abnormal features can be excluded. Mental and physical excitement in the patient must also be guarded against.

It is proper to consider whether other persons similarly circumstanced do or do not present like phenomena. Without giving exact figures, it may be said that a continuous series of choreic and other children have been brought to the clinic during the same period as the epileptics. But, although attention has been directed to it, no similar proportion of aberrations has been found. In the choreics, irritable heart, cardiac murmurs, and regional pain are frequent, but the other deviations exceptional.

The further question arises, how constant is any one or any combination of these in the same individual? The influence of the attacks on the cardiac phenomena is more marked than on the pupillary. Otherwise they persist for weeks and months with but slight variation, diminishing gradually if the person be progressing towards a cure.

PRE- AND POST-PAROXYSMAL CARDIO-VASCULAR PHENOMENA.

The variations in cardiac action, above described, are not always the same about the time of the seizures. Where these latter are frequent the short intervals may present only spasm-phenomena. But where the intervals are longer we can usually distinguish the symptoms attending the paroxysms from those intervening and more continuous. They are not altogether alike even in kind.

Towards the approach of a seizure there may be a decided accentuation and increase, occasionally even sufficient to warrant the prediction of an impending attack. The opportunity of observing shortly after a seizure is more frequent. In a possible majority of cases we then find the aberrant action more marked, and it may be only at such times that any of these peculiarities appear. But not rarely the opposite is then found—a full regular pulse where at other times weak and fast; and this latter may occur even where the seizure has been *preceded* by an increased disturbance.

Voisin, Magnan and Féré have described and studied the pulse-changes about the time of the seizure. The last observer, from experiments on healthy subjects, showed that after violent muscular efforts the same modifications were present; but he also (1889) found an increase of 200 to 300 grammes in the arterial pressure *during the aura.*

François-Franck (1887) by cortical irritation produced changes in the blood-pressure and the heart-action, both with and without epileptic seizures.

PATHOLOGY.

Are these cardiac phenomena—representing, as they collectively do, a weakening and irregularity of the heart's action—exclusively the result, more or less grossly mechanical, of the repeated heart-strains which the convulsions certainly produce?[2] That those of the interim may be to some extent, and those directly after the paroxysm are largely of this origin is clear. Or is there also a direct nervous influence affecting abnormally the heart or vascular system? And secondary to the latter question is another—whether such morbid nerve-influences are active only about the time of the paroxysms, or are they to some extent continuous?

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[2] This is doubtless the cause of the total hypertrophy of the heart with dilatation observed in epileptics by Jastrowitz of Berlin (reported in *Wien. Med. Wchr.*, 1889, No. 31, 1212-1213). The dilatation is on a par with that which sometimes occurs acutely in severe chills, only that by repetition it is increased and becomes chronic. To meet the repeated strains the heart, if able, hypertrophies just as *e. g.* from the hill-climbing of oertel. J. however calls it idiopathic disease of the heart-muscle, and assumes an unknown nervous influence.

The fact that as a premonition of the seizures there may be decided alterations in the pulse, that during the aura-stage there may be a great increase in the arterial pressure, that where the free intervals are of much length it may be quite possible to distinguish between the paroxysmal and the inter-paroxysmal pulse-changes, and finally that in cases of definite heart-lesion it has repeatedly been possible to fully control the convulsions by regulating and strengthening the heart's action, and yet only so long as this latter was possible, all these facts disprove the hypothesis of a purely mechanical or secondary origin of these pulse-changes. They indicate that there is some other factor, evidently some form of nerve-influence and not limited in time of action to the paroxysms alone. That this is of cortical origin is rendered probable by the experiments of Franck already mentioned.

THERAPEUTIC INDICATIONS.

These cardio-vascular manifestations give a strong warrant for the use of digitalis in selected but numerous cases. This drug has been mentioned favorably by various writers, but has hardly been accorded its full right. The fact that it acts not alone on the heart but on the arteries in general makes it especially useful. In a certain minority of cases it is far more important and lasting in its benefit than the bromides, though readily combinable with them. But both to secure its best effect and to allow of its prolonged use, *small doses are demanded.* A drachm to a drachm and a half of the tincture a week is all that can advantageously be given for any length of time. Two drachms a week is the maximum for even short periods. Later it may be tapered to half a drachm before stopping. Of course this applies to youths and young adults.

Occasionally strophanthus may better fill some indication, but its different action makes it less generally available. My trials of it in epilepsy have not been encouraging, however satisfactory in troubles of other kinds. But possibly the later commendations (*e. g.* by Poulet) should be accorded some consideration.

Nux or its alkaloids are known to be occasionally invaluable for a short preliminary treatment in conditions of weak heart.

In most cases the use of tobacco in any form, especially by youths, is to be condemned. Various tonics (as tobacco, coffee, tea, alcohol) are amongst the best recognized causes of tachycardia and other functional heart troubles, and hence are to be considered injurious for most epileptics.

In some cases, not only of valvular trouble, but where there is a weak heart without special lesion, the plan of lying down if warned by a sufficient aura or other premonition—will abort an attack. This plan has proven more often possible in private than in the duller dispensary patients. It is also attested by a well-known case of Stoker. Some intelligence on the patient's part is necessary and an imperative realization of the urgency and importance of this little procedure. In the same sense, lifting or overwork (too rapid, prolonged or excessive) is in cases with such weak circulation to be carefully guarded against.

Occasionally, on the contrary, it is true that labor improves the patient, and without doubt, as urged by Putzel, some occupation suitable to the patient's physical ability is advantageous rather than otherwise. It is only to be remembered that many of these subjects are not able to do a fair average and are greatly injured by any excess.

(*To be continued.*)